CHAPTER 14
METHODS OF ESTIMATING

14-1. General Considerations. The work involved in a drilling and grouting program can only be approximated in advance of construction. Quantities are estimated for bidding purposes, but substantial variations are common. The contract specifications and bid items should be prepared so that the estimated quantities for each of the bid items may vary substantially without affecting unit prices. However, a concerted effort must be made to estimate the quantity of drilling and of grouting materials (e.g., grout take) that will be required.

14-2. Test Grouting. For medium and large projects, probably the most reliable method for estimating grout take is to conduct a test grouting program as discussed in paragraph 3-5. The site chosen for testing should be geologically characteristic of what was found during subsurface exploration.

14-3. Grouting Records. A less reliable method for estimating quantities of grouting materials is to refer to grouting records from sites located in areas that have similar geology and rock types. This method will give a general feel for the quantities; however, it will require extensive experience and knowledge of grouting on the part of the estimator to extrapolate the data to another site. A major problem in utilizing this method is the possibility of differing approaches or philosophies of the people doing the grouting. Individual grout specialists working in similar environments may place considerably different quantities of grout, according to their various techniques, but a satisfactory grout job can be achieved in each case.

14-4. Evaluation of Exploration Borings. The evaluation of the cores from the exploration program, as well as the results of the water pressure tests, is fundamental in the initial stages of preparing a grouting estimate. Utilizing this method alone for estimating would be unreliable since it has been proven that rock formations which take water during pressure testing frequently do not take grout.

14-5. "Unit Take" Estimates. A method frequently used during preparation of detailed estimates for drilling and grouting programs is called the "unit take" method. In the procedure used for this method the area to be grouted is divided into horizontal reaches and vertical zones of varying permeability, based on site geology and pressure test results. Estimates are made of the number of primary and split-spaced holes required to complete each area and zone. Grout take in cubic feet per foot of grout hole is assigned, as well as the reduction in grout take for each split and zone. The amount of grout take in each series of split-spaced holes normally would be less than the preceding set of holes, and in multiple lines, take in each line less than a previously grouted line. Unless geologic conditions indicate otherwise, the unit take would normally decrease with depth. Each zone of each hole is assigned an estimated take in cubic feet of grout per linear foot of grout hole. A typical estimate using this method may look like the following:

Reach "A"

(Grout Take in Cubic Feet/Foot)

		Depth	Primary	Secondary	Tertiary	Quaternary
Line A:	Zone 1	0-10	1.5	0.75	0.2	0.05
	Zone 2	10-25	1.0	0.4	0.1	--
	Zone 3	25-50	0.2	0.25	0.1	--
	Zone 4	50-100	0.1	0.01	--	--

(Note: The above figures are for illustration only and should not be used for purposes of estimating, criteria for split spacing, or completion of grouting.)

For most major projects, all of the methods discussed above should be used and results compared to accomplish an adequate grout estimate.

14-6. Bid Items. Experience of the Corps of Engineers indicates that the items discussed in subsequent paragraphs should be considered for inclusion in any estimate or bid schedule for a drilling and grouting program. The bid items must fit the needs of the particular project. Guidance in providing for variations in estimated quantities by using subdivided items is given in ER 1180-1-1.

a. Mobilization and Demobilization. Drilling and grouting equipment must be assembled at the job site before a grouting program can be started and must be removed from the site when the work is completed regardless of the amount of work actually performed. A separate pay item or pay items for these operations, therefore, should be included in the specifications, and the contractor will be guaranteed payment whether work under the other items of the program is performed or not. Payment for the two features of work is commonly set up under one pay item with provisions for a partial payment to the contractor upon completion of the mobilization and for payment of the remainder after the grouting program is completed and the materials and equipment are removed from the site to the satisfaction of the contracting officer.

b. Environmental Protection. A separate pay item may be included in the specifications. Environment protection is defined in this manual as the retention of the environment in its natural state to the greatest possible extent during project construction.

c. Drilling Grout Holes.

(1) A minimum diameter hole is generally specified. If different diameter holes are required by the contract, separate pay items should be provided. Separate pay items may also be warranted for the various depths or angles, or where some of the drilling is to be done under special conditions,

such as from a gallery or tunnel. If it becomes necessary to drill the grout from a hole after set, through no fault of the contractor, a special payment provision for redrilling should be provided. This is usually specified as one-half of the cost of initially drilling the grout hole.

(2) The contract drawings and specifications should clearly indicate the direction, maximum angle, maximum depths, and allowable deviation therefrom.

(3) The amount of drilling should be estimated on the basis of the job as planned and shown on the drawings. The amount of drilling anticipated for each drilling item should be shown.

d. Drilling Exploratory Holes. To determine the effectiveness of the grout curtain or portions thereof during grouting operations it may be required to drill exploratory holes at key locations. Drilling of exploratory holes will be measured for payment on the basis of linear feet of holes actually drilled. If a portion of exploratory or grout hole drilling is to be done through overburden, a separate pay item should also be included for this portion (see c above).

e. Pressure Washing and Pressure Testing. Preliminary washing of the grout hole usually is included for payment as a part of the drilling operations, and a separate pay item is not necessary. Pressure washing and testing are essential parts of the grouting program and therefore should be paid for as a separate item. Quantities of pressure washing and pressure testing ordinarily are measured for payment purposes in terms of units of time required to do the work. Pressure washing and pressure testing are closely related and the operations performed are similar; therefore, payments for both operations are commonly combined in one pay item. Although the extent of pressure washing will depend on the conditions actually encountered, an approximation of the amount that will be required, as well as the amount of pressure testing expected to be done, should be made for inclusion in the estimate.

f. Grout Placement. The pay item for placing grout should cover the labor, the use of equipment, and the necessary supplies (other than grouting materials) required to mix and to inject the grout into the holes. The stage-grouting method, if it is employed, may also include cleaning grout from the holes at the completion of a grouting stage. Placing grout is frequently paid for by volume of the grouting materials (except water) to be injected, i.e., cubic feet of solids. An estimate of the quantity of grout must be made even though the actual amount is not known in advance. Payment for grout injection by the hour may be better in many cases, and would include labor and use of equipment to inject the grout into the holes. In cases where it is anticipated that extensive use may be made of very thin mixes to grout fine fractures, an alternative method would be to pay for placement of total volumes including water. This would assure that a contractor is fairly compensated for long time periods placing small amounts of cement.

g. Connections to Grout Holes. The labor required to hook up to a grout hole is independent of the effort involved in placing grout, and a separate payment may be desirable for each hookup or connection. The payment may consist of a fixed or bid price per grout hookup or connection.

h. Grout Materials. Separate pay items should be established for each of the grout materials (except water) anticipated or planned to be used. The estimated quantity of each, expressed by volume or weight, should be derived from past experience, knowledge of the geologic conditions, and from test grouting, if performed.

i. Pipe and Fittings. All pipe to be embedded in concrete or in rock through which holes will be drilled and grouted, and the fittings used in connection therewith, should be covered by one pay item regardless of the different sizes used. The quantity should be estimated on the basis of the number of pounds of pipe and fittings that will be required.

j. Drilling Drain Holes. The drilling of drain holes should be covered by separate items for each hole size. Should both drilling in the open and from galleries be required on the same job, separate items for these conditions may be desirable. The spacing and the depth of drain holes can ordinarily be predetermined with a greater degree of accuracy than can grout holes. The quantity for each item should be expressed in linear feet or meters.